EFFECTS OF SPECIMEN DIMENSION ON DISPLACEMENT FIELD IN V-NOTCH RAIL SHEAR TEST

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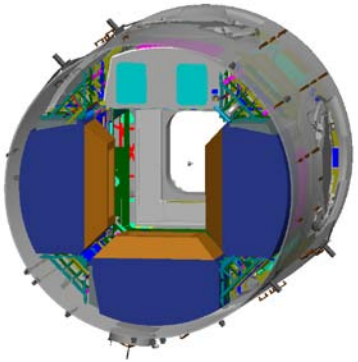
Dimensional Effects on Strain Field in V-notch Rail Shear

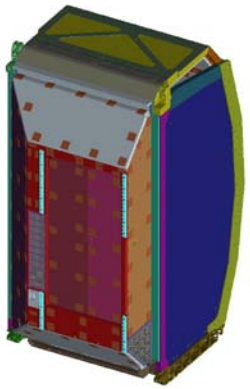
- Introduction
  - Existing Project Data
  - Relevance to Composites Test Community
- Experimental
  - Specimen Dimensions
  - ARAMIS Strain Field Measurement
- Results
  - Strain Field Video Files
- Conclusion

Dimensional Effects on Strain Field in V-notch Rail Shear

- Introduction -- Existing Project Data

- ***ISS Habitability Project Crew Quarters***
  - **Node 2 Rack Assembly**
  - **Composite Sandwich Structure Side Walls and Floor**
  - **Design Allowable Property Verification for CMH-17 Published Material System**





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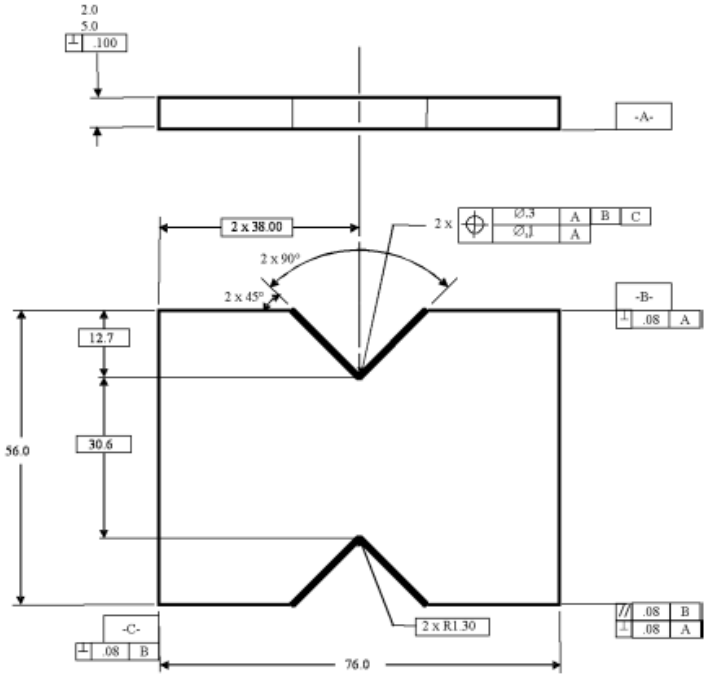
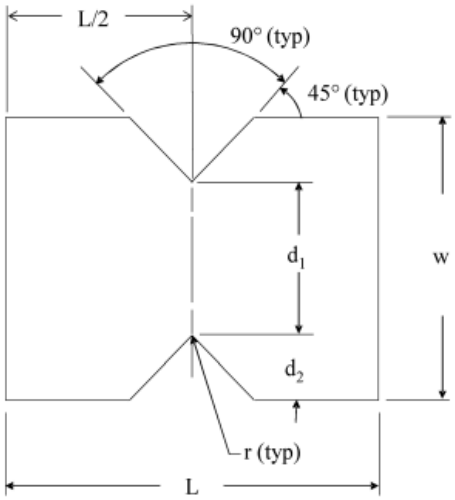
Dimensional Effects on Strain Field in V-notch Rail Shear

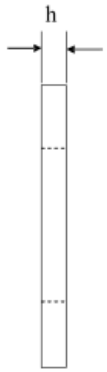
- Introduction
  - Relevance to Test Community
    - Recent discussion of proposed combined loading V-notch shear test at ASTM D30 meeting
    - ASTM D 7078 specimen dimension tolerances
      - Length, Width, Notch Depth: +/- 1mm
      - Parallel and Perpendicular: +/- 0.3mm
      - Tip Radius: +/- 0.3mm
      - Angles +/- 0.5 degrees
    - Applicable Machining Methods
      - Water-Jet (edge finish?)
      - Diamond Saw (tip radius?)

Dimensional Effects on Strain Field in V-notch Rail Shear





Front



End

Nominal Specimen Dimensions

NOTE—Interpret Fig. 7 in accordance with ANSI Y14.5M-1982, subject to the following:

(1) All dimensions in millimetres with decimal tolerances as follows:

No decimal	0.X	0.XX
±3	±1	±0.3

(2) All angles have a tolerance of ±0.5°.
(3) Ply orientation direction tolerance relative to –A- (or to –B-) within ±0.5°.
(4) Finish on machined edges not to exceed 1.6 √. Finish on V-notch not to exceed 0.8 √ (symbology is in accordance with ANSI/ASME B46.1-1985, with roughness height in micrometers.)
(5) Values to be provided for the following, subject to any ranges shown on the field of Fig. 7: material, lay-up, and ply orientation reference relative to –A-, and coupon thickness.

d_1 = 31.0 mm [1.20 in.]
d_2 = 12.7 mm [0.50 in.]
h = as required
L = 76.0 mm [3.0 in.]
r = 1.3 mm [0.05 in.]
w = 56.0 mm [2.20 in.]

Dimensional Effects on Strain Field in V-notch Rail Shear

- Experimental
  - AS4/3501-6 [0/90/+45/-45]s carbon/epoxy unidirectional tape.
  - 108GL/3501-6 E-glass fabric/epoxy scrim outer plys.
  - Shear modulus strain gages on front.
  - ARAMIS speckle paint on back.
  - 5 Specimens with various dimensions.
  - 10 additional specimens with strain gage only.

Dimensional Effects on Strain Field in V-notch Rail Shear

- Specimen Dimensions
  - Original specimens rejected by manufacturing quality control and original measurement records not available.
    - Specimen dimensions measured from test images captured by ARAMIS system.
    - Calibrated size by measurement of fixture.
      - Estimated accuracy (+/- 0.5mm)
  - Project schedule and analysts immediate need justified preliminary tests using non-standard specimens.
  - ARAMIS capability suggested to measure effects of Notch misalignment and tip radius.

Dimensional Effects on Strain Field in V-notch Rail Shear

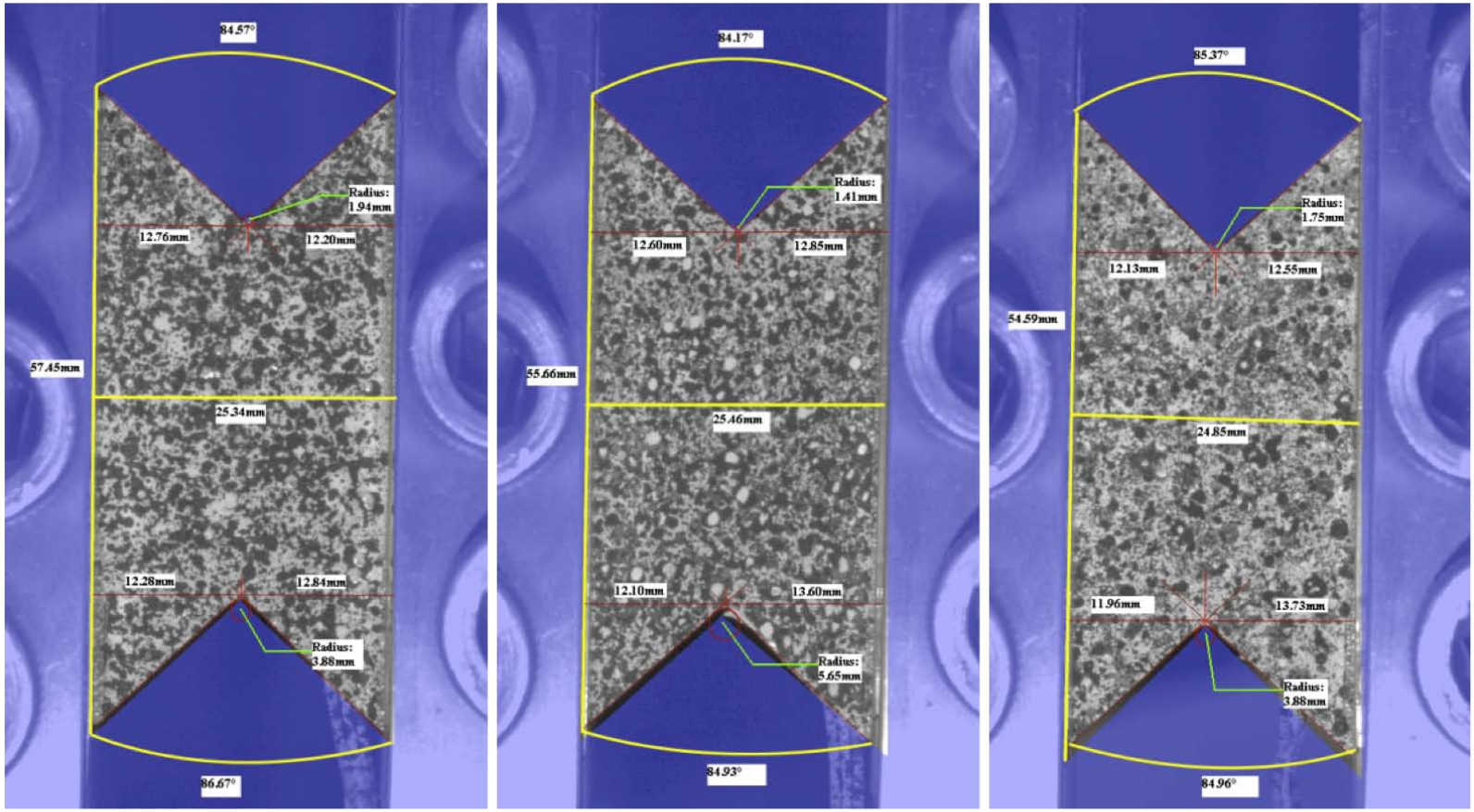
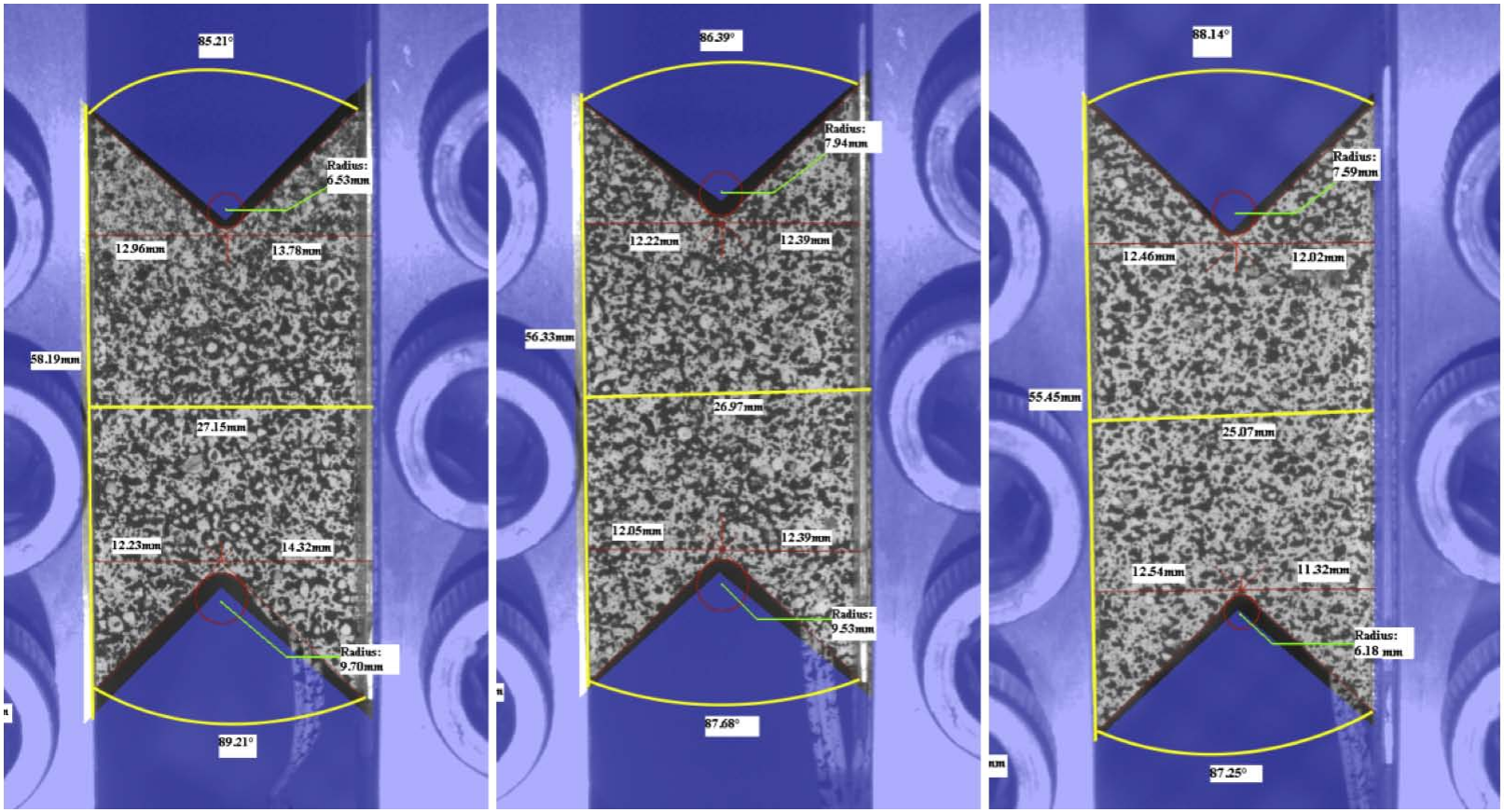


Figure 2a) ABB-01 2b) ABB-02 2c) ABB-04

Dimensional Effects on Strain Field in V-notch Rail Shear



2d) ABB-05 2e) ABB-07 2f) ABB-10

Dimensional Effects on Strain Field in V-notch Rail Shear

- Specimen Dimensions
  - Notch Alignment +/- ~2mm
  - Tip Radius +/- ~3mm
  - Angles +/- 5 degrees

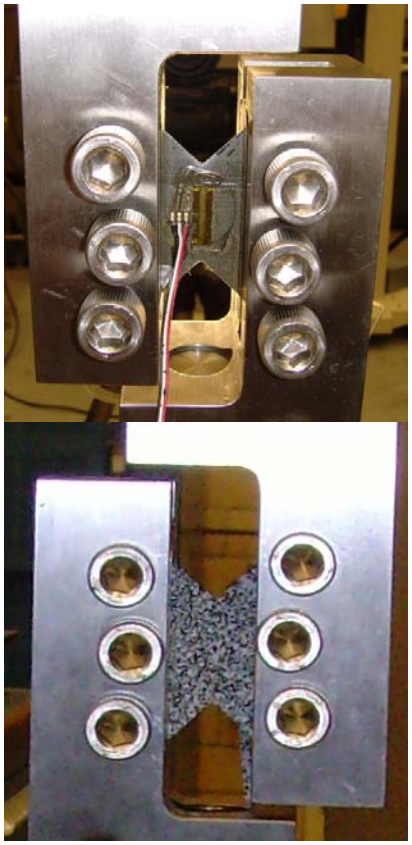
Table 1 Pre-Test Specimen Notch Dimensions

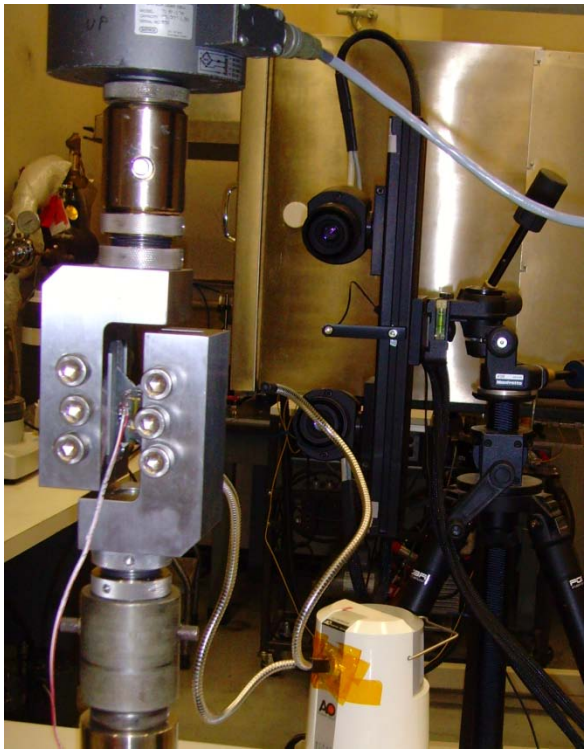
	ABB-01	ABB-02	ABB-04	ABB-05	ABB-07	ABB-10
Vtl	12.76	12.60	12.13	12.96	12.22	12.46
Vtr	12.20	12.85	12.55	13.78	12.39	12.02
Vbl	12.28	12.10	11.96	12.23	12.05	12.54
Vbr	12.84	13.60	13.73	14.32	12.39	11.32
Rt	0.97	0.71	0.88	3.27	3.97	3.80
Rb	1.94	2.83	1.94	4.85	4.77	3.09
At	84.57	84.17	85.37	85.21	86.39	88.14
Ab	86.67	84.93	84.96	89.21	87.68	87.25

Vtl= distance from fixture to V tip, t=top, l=left (mm); ie: Vtr (top right) Vbl (bottom right)
Rt= Notch tip radius, t=top (mm), Rb= Notch tip radius, b=bottom (mm)
At= Notch angle, t=top (degrees), Ab=Notch angle, b=bottom

Dimensional Effects on Strain Field in V-notch Rail Shear

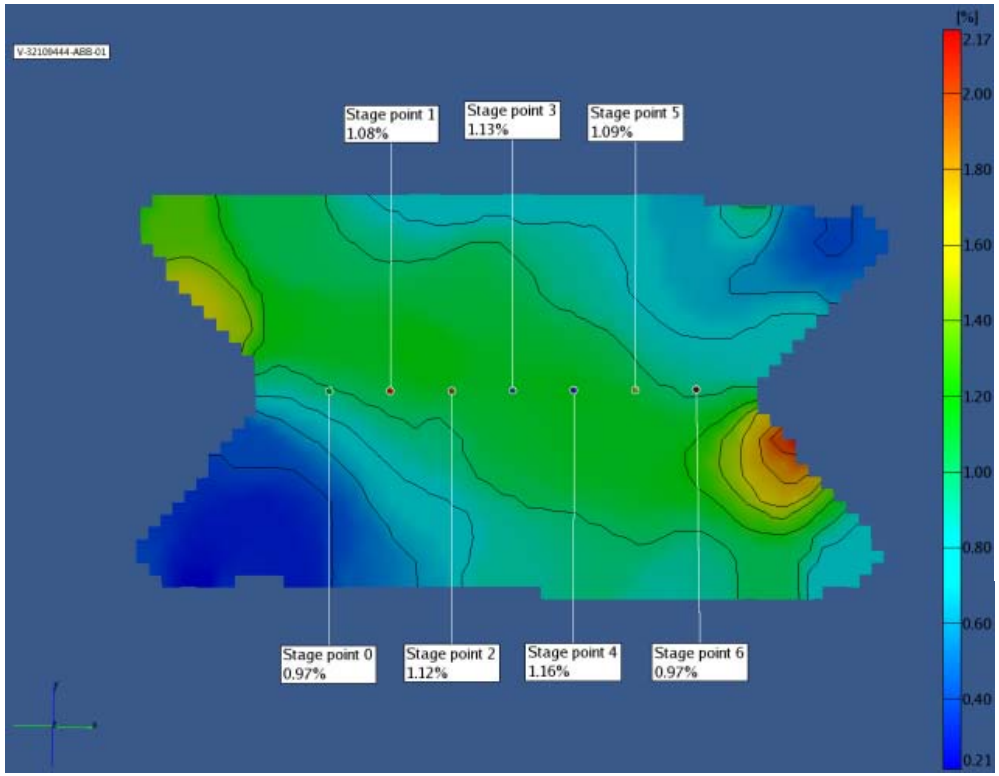
- Mechanical Test Setup
  - Specimen and Camera Configuration

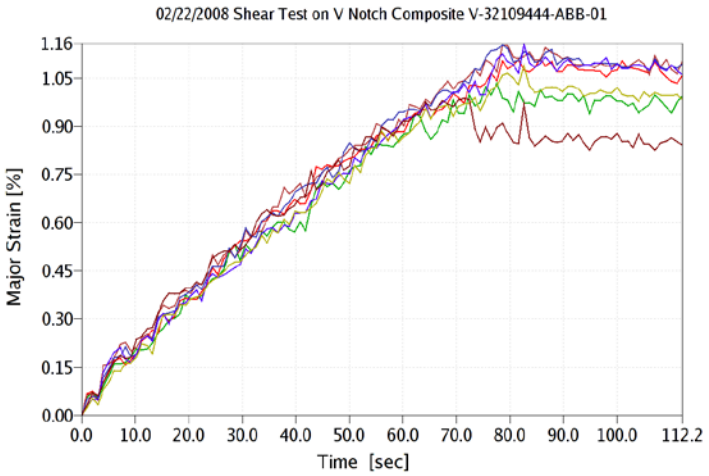




Dimensional Effects on Strain Field in V-notch Rail Shear

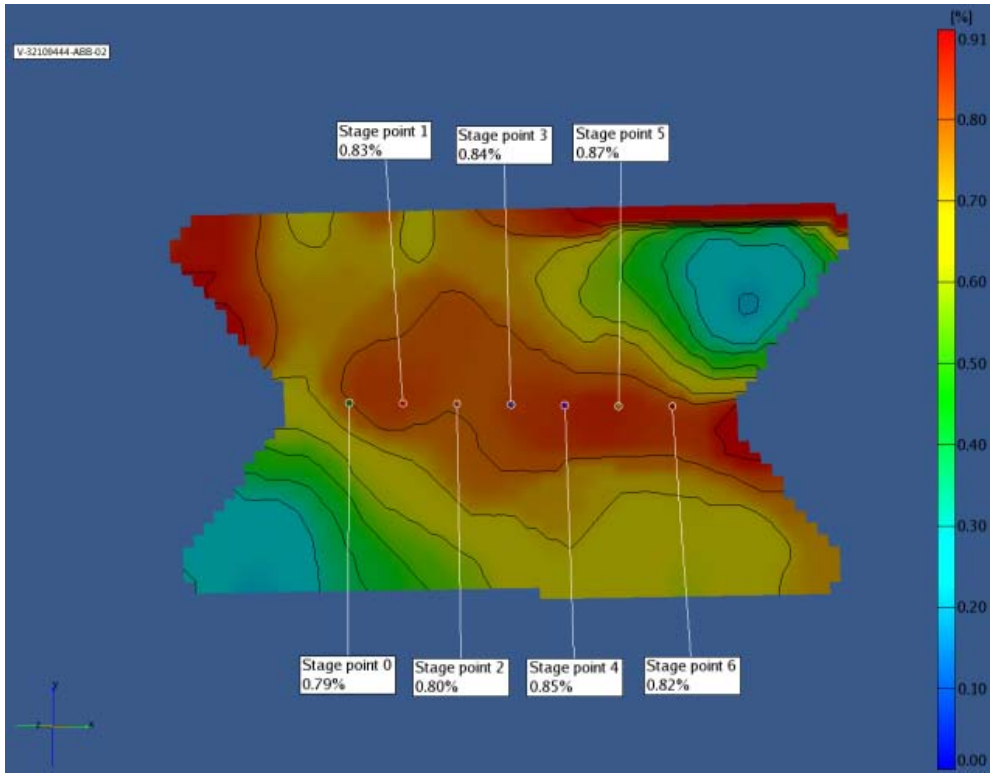
- Results
  - Strain field from final frames prior to break.

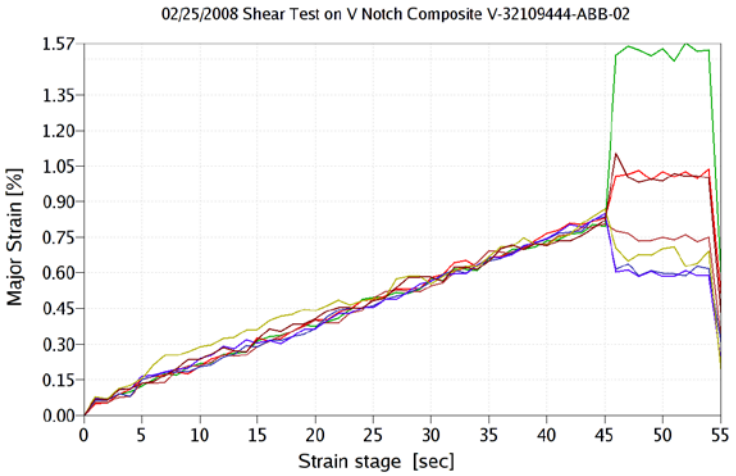




Specimen ABB-01

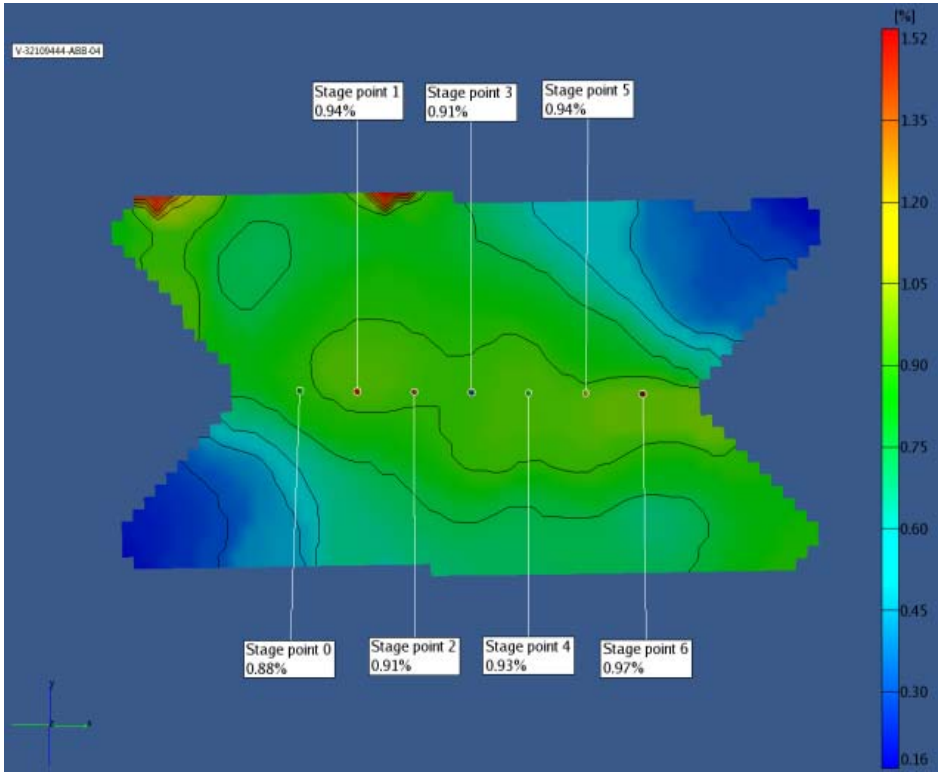
Dimensional Effects on Strain Field in V-notch Rail Shear

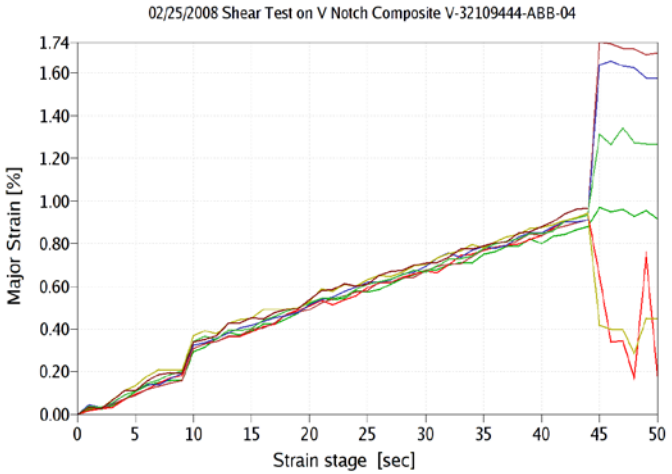




Specimen ABB-02

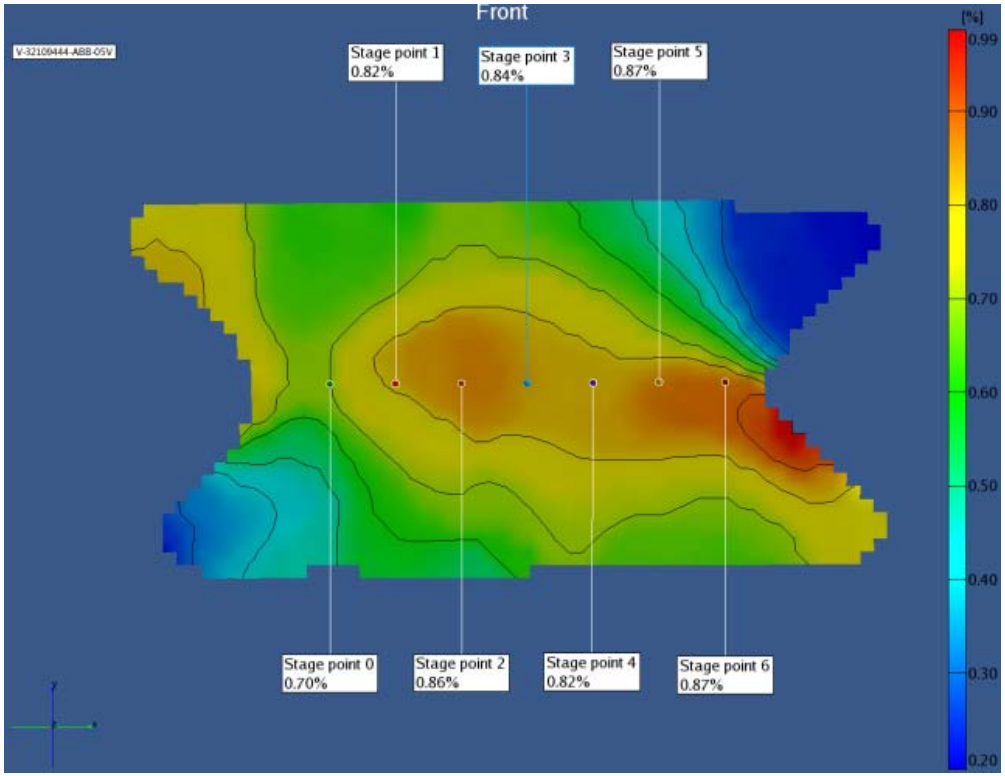
Dimensional Effects on Strain Field in V-notch Rail Shear

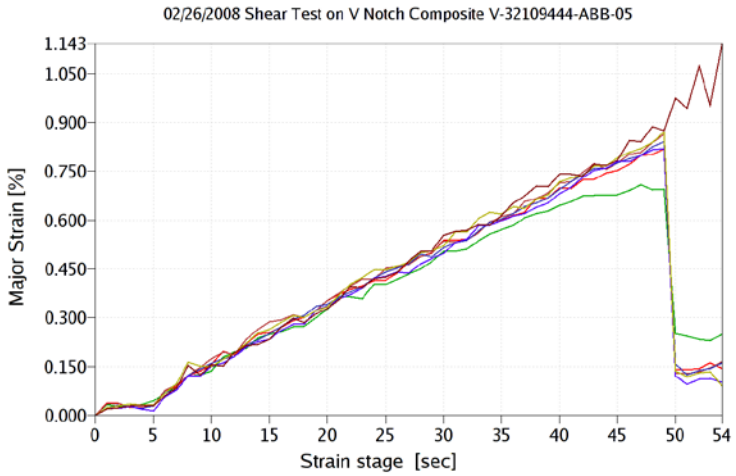




Specimen ABB-04

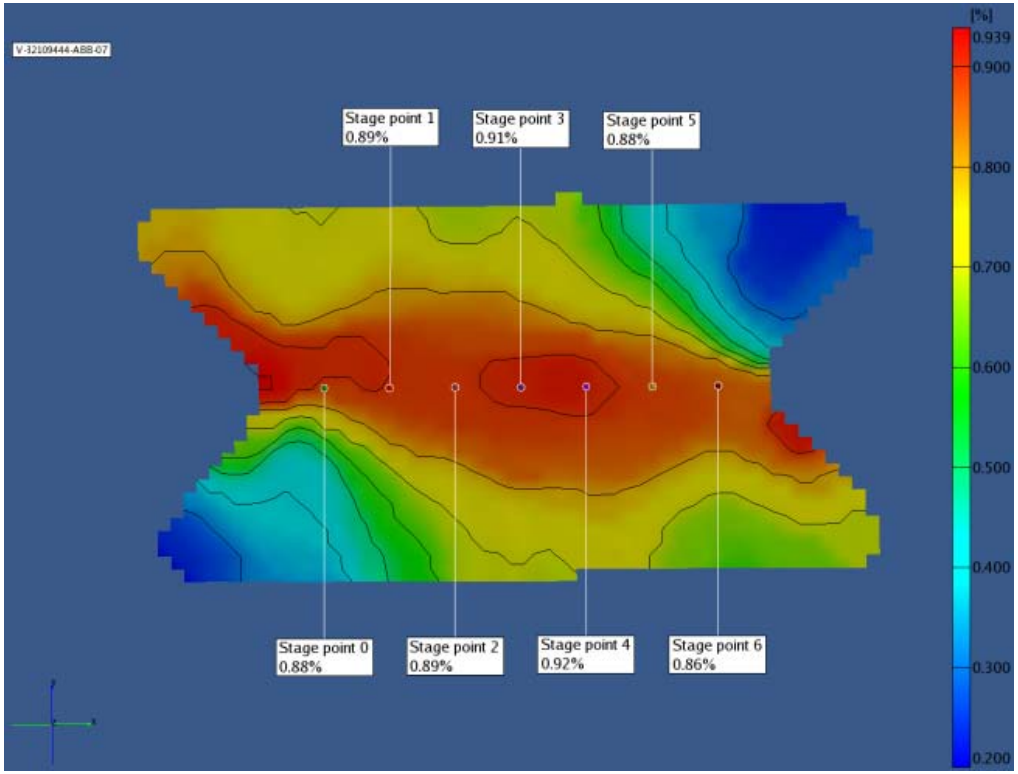
Dimensional Effects on Strain Field in V-notch Rail Shear

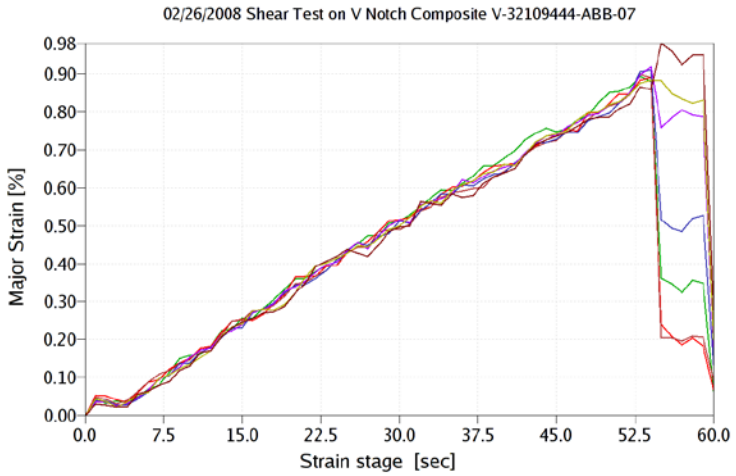




Specimen ABB-05

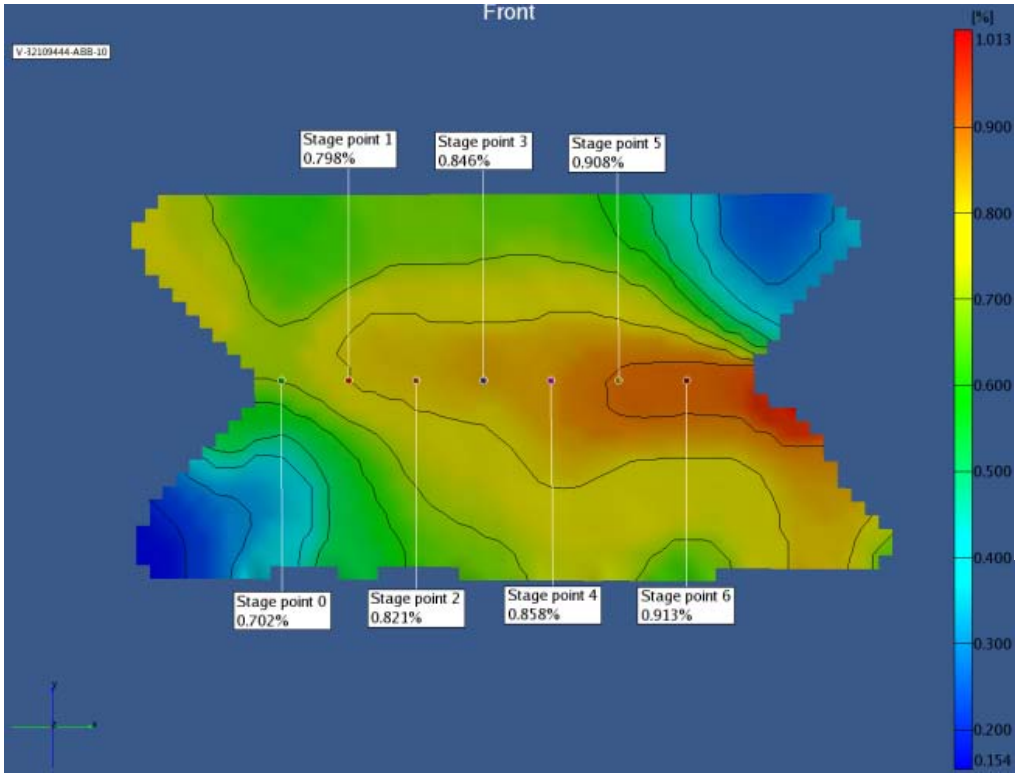
Dimensional Effects on Strain Field in V-notch Rail Shear

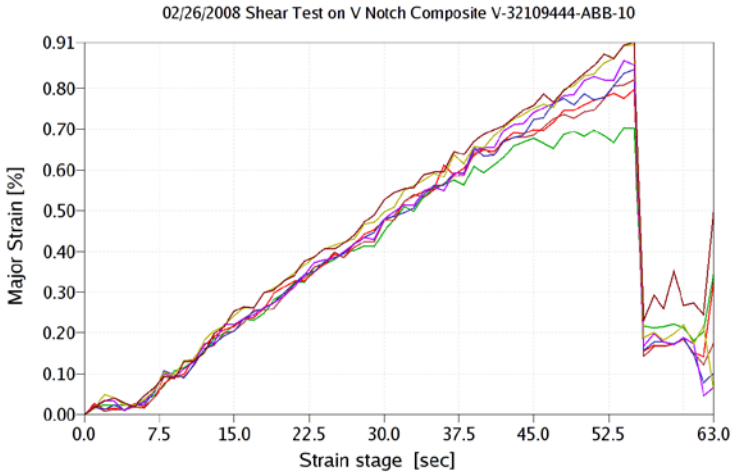




Specimen ABB-07

Dimensional Effects on Strain Field in V-notch Rail Shear



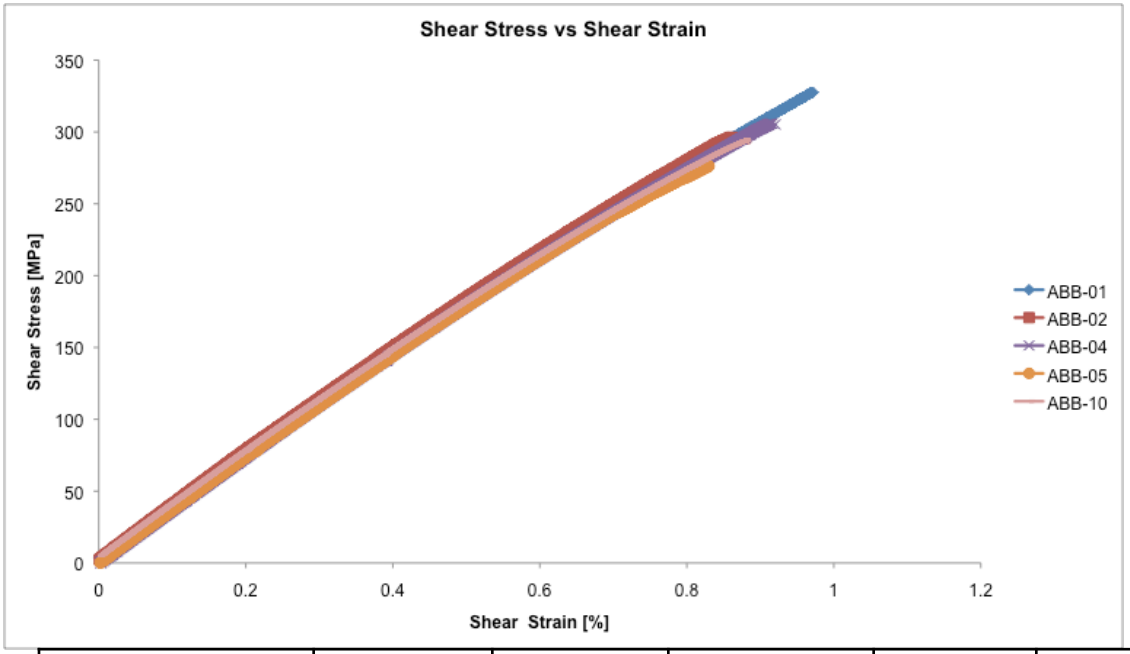


Specimen ABB-10

Dimensional Effects on Strain Field in V-notch Rail Shear

- Evolution of Strain Field Videos
  - Fixed Scale for development of overall strains
  - Auto-Scale for visualization of variability across surface.
  - Raw data may be made available for study.

Dimensional Effects on Strain Field in V-notch Rail Shear



Specimen #	Width (mm)	Thick (mm)	Peak Load (N)	S12 (MPa)	E12 (GPa)	Break Strain (%)
ABB-01	33.02	1.17	13298.62	344.48	37.70	0.97
ABB-02	33.02	1.17	11428.02	296.02	38.25	0.86
ABB-04	33.02	1.17	11799.82	305.65	37.42	0.92
ABB-05	33.02	1.17	10655.46	276.01	37.23	0.83
ABB-07	33.02	1.17	11908.46	308.47	37.33	0.93
ABB-10	33.02	1.17	11356.99	294.18	37.31	0.88
AVE	33.02	1.17	11741.23	304.14	37.54	0.90
SD	0.00	0.00	881.08	22.82	0.38	0.05
%CoV	0	0	7.50	7.50	1.02	5.56

Dimensional Effects on Strain Field in V-notch Rail Shear

- Results of Standard Specimens
  - Dimensions per ASTM-D-7078
  - Same test configuration.
  - Shear modulus strain gages.

Specimen #	Width (mm)	Thick (mm)	Peak Load (N)	S12 (Mpa)	E12 (Gpa)	Break Strain (%)
4	31.83	1.02	10961.43	338.22	40.84	0.87
5	31.81	1.04	11295.95	340.17	41.25	0.87
7	31.75	1.04	11577.76	349.36	40.71	0.88
8	32.26	1.04	10316.35	306.39	41.16	0.71
9	32.00	1.04	11926.02	357.01	39.95	0.89
10	32.26	1.04	12008.42	356.65	42.52	0.88
11	32.00	1.04	9356.21	280.08	39.52	0.68
12	32.00	1.04	11003.80	329.40	42.43	0.82
AVG	31.99	1.04	11055.74	332.16	41.05	0.83
SD	0.19	0.01	881.71	26.72	1.06	0.08
%CoV	0.60	0.86	7.98	8.04	2.57	10.03

Dimensional Effects on Strain Field in V-notch Rail Shear

- Conclusions
  - Higher strength and modulus values resulted from standard specimens (~10%)
  - Stress concentrations in non-standard specimens at notches and at grips.
  - Strain field variability in gage sections evident in non-standard specimens.
  - Standard dimension tolerances adequate and appropriate for most conditions.
    - Develop acceptable machining techniques.